EUROPEAN PATENT OFFICE

Patent Abstracts of Japan

PUBLICATION NUMBER : 2002196134
PUBLICATION DATE : 10-07-02

APPLICATION DATE : 22-12-00
APPLICATION NUMBER : 2000390619

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INT.CL. : G02B 5/30 B29C 55/16 C08J 5/18 G02F 1/1335 G02F 1/13363 // B29K 86:00 B29K101:12 B29L 7:00 B29L 11:00 C08L 45:00

TITLE : OPTICALLY COMPENSATED FILM, METHOD FOR MANUFACTURING THE SAME AND POLARIZATION PLATE AND LIQUID CRYSTAL DISPLAY DEVICE USING THE FILM

ABSTRACT : PROBLEM TO BE SOLVED: To provide an optically compensated film and a method for manufacturing the film which easily develops the biaxial characteristics and has required retardation characteristics distributed uniformly in the plane, and to provide a polarization plate and a liquid crystal display which use the film.

SOLUTION: The optically compensated film is manufactured, by biaxially stretching a thermoplastic resin film at a time in the longitudinal direction and in the lateral direction and the film shows 0 to 500 nm retardation in the plane (Re=(nx-ny)d) and 0 to 500 nm retardation in the thickness direction (Rth=(nx-ny)d), satisfying Re/Rth<1, wherein d is the thickness of the film, nx, ny are the principal refractive indices in the plane of the film, under the condition of nx>ny, and nz is the principal refractive index in the thickness direction. By subjecting the film to a process of reducing the drawing rate in the lateral direction after the simultaneous biaxial stretching, uniformity in the film plane is further improved.

KOKAI PATENT APPLICATION NO. 2002-196134

OPTICAL COMPENSATION FILM AND MANUFACTURING METHOD FOR IT, AND POLARIZING SHEET AND LIQUID CRYSTAL DISPLAY DEVICE MADE WITH SAID FILM

[Translated from Japanese]

[Translation No. LPX30458]

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JAPANESE PATENT OFFICE (JP)

PATENT JOURNAL (A)

KOKAI PATENT APPLICATION NO. 2002-196134
(P2002-196134A)

Technical Indication Section

Int. Cl.^{7}:	G 02 B	5/30
	B 29 C	55/16
	C 08 J	5/18
	G 02 F	1/1335
		1/13363
	//B 29 K	86:00
		101:12
	B 29 L	7:00
		11:00
	C 08 L	45:00
		65:00
	G 02 B	5/30
	B 29 C	55/16
	C 08 J	5/18
	G 02 F	1/1335
		1/13363
	//B 29 K	86:00
		101:12
	B 29 L	7:00
		11:00
	C 08 L	45:00
		65:00
Identification Code:	CER	
	CEZ	
	CER	
	CEZ	
Sequence Nos. for Office Use:	FI	
Filing No.:	2000-390619	
Filing Date:	December 22, 2000	

Publication Date:	July 10, 2002
No. of Claims:	10 OL (Total of 7 pages in the [Japanese] document)
Examination Request:	Not filed
Form of Application:	Paper document

OPTICAL COMPENSATION FILM AND MANUFACTURING METHOD FOR IT, AND POLARIZING SHEET AND LIQUID CRYSTAL DISPLAY DEVICE MADE WITH SAID FILM

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F-Term (for reference):	2H049 BA02 BA04 BA06 BA27 BA42 BB03 BB43 BC01 BC03 BC22 2H091 FA08X FA08Z FA11X FA11Z FC09 FD06 HA10 KA02 LA30 4F071 AA39 AA69 AF29Y AF31Y BB08 BC01 4F210 AA49 AH73 QA02 QC07 QG01 QG17 QL09 QL10

[There are no amendments to this patent.]

[Translator's note: The format of the source document supplied by the requester and used for this translation had been changed from the original Japanese Patent Application submitted by the applicant to accommodate machine translation.]

Specification

[Title of the invention]

Optical compensation film and manufacturing method for it, and polarizing sheet and liquid crystal display device made with said film

[Abstract]

[Purpose] The purpose of the present invention is to provided an optical compensation film in which forming of biaxial characteristics is made easy and retardation characteristics required are uniformly provided in the in-plane directions, and manufacturing method for it, and polarizing sheet and liquid crystal display made of same.

[Means of solution] In drawing of thermoplastic resin film, simultaneous biaxial drawing is done in the vertical direction and horizontal direction so as to form an in-plane retardation value of ($Re=(n_x-n_y)d$) of 0 to 500 nm and thickness direction retardation value of ($Rth=(n_x-n_z)d$) of 0 to 500 nm and Re/Rth [sic] when the thickness of the film is d, primary in-plane refractive indices

are n_x and n_y, the primary refractive index in the thickness direction is n_z and $n_x>n_y$.

[Claims of the invention]

[Claim 1] A method of manufacturing an optical compensation film by drawing a thermoplastic resin film, which manufacturing method of an optical compensation film is characterized by the fact that simultaneous drawing is done in the vertical direction and in the horizontal direction.

[Claim 2] The manufacturing method described in claim 1 in which a relaxation process for the horizontal drawing ratio is provided after the simultaneous drawing process, and the relaxation ratio in said relaxation process is 20% or less.

[Claim 3] [A film in which] the in-plane retardation value ($Re=(n_x-n_y)d$) is 0 to 500 nm and thickness direction retardation value ($Rth=(n_x-n_z)d$) is 0 to 500 nm and Re/Rth [sic] when the thickness of the film is d, primary in-plane refractive index is n_x and n_y, the primary refractive index in the thickness direction is n_z and $n_x>n_y$.

[Claim 4] The optical compensation film described in claim 3 in which the in-plane retardation value (Re) is 10 to 100 nm, thickness direction retardation value (Rth) is 100 to 300 nm and Re/Rth is 3 to 5.

[Claim 5] The optical compensation film described in claim 3 or claim 4 in which the in-plane retardation distribution is within ±10% at 80% of the width of the sheet.

[Claim 6] The optical compensation film described in one of claims 3 to 5 in which the thermoplastic resin film is norbornene type resin film.

[Claim 7] The polarizing sheet structured of a laminate of the optical compensation film produced by the method described in claim 1 or 2 and a polarizing sheet.

[Claim 8] The polarizing sheet structured of a laminate of the optical compensation film produced by the method described in one of claims 3 to 6 and a polarizing sheet.

[Claim 9] A liquid crystal display device having the optical compensation film described in

one of claims 3 to 6 on at least one side of the liquid crystal cell.

[Claim 10] A liquid crystal display device having the polarizing sheet described in claim 7 or 8 on at least one side of the liquid crystal cell.

[Detailed description of the invention]

[0001]

[Technical field of the invention]

The present invention pertains to an optical compensation film used for improvement in the viewing angle or contrast of a liquid crystal display device, and to a manufacturing method of same, and to a polarizing sheet and liquid crystal display device made with the aforementioned film.

[0002]

[Prior art]

A liquid crystal display device with high contrast the utilizes STN type birefringence, etc. is used for image displays of personal computers and word processors. In the aforementioned liquid crystal display device, linearly polarized incident light by polarizing sheet forms elliptically polarized light based on birefringence at the polarizing sheet, and when observed through a polarizing sheet, yellow or blue coloring of the display poses a problem. In order to prevent coloring by restoring the elliptically polarized light to linearly polarized light after transmitting from the liquid crystal cell, use of the FTN system where a phase shift sheet (optical compensation film) is inserted between the liquid crystal cell and polarizing sheet is proposed as a means to compensate for the phase shift based on the birefringence of the liquid crystal cell.

[0003]

However, when a normally drawn film is used as the optical compensation film in the aforementioned FTN system, coloring occurs even when the position of viewing is changed slightly, and the viewing angle for observing the display as black and white is narrow, and furthermore, the viewing angle with high contrast is narrow and visibility is inferior. Thus, as an

optical compensation film used for improvement in the viewing angle or contrast of liquid crystal display device, [a film in which] in-plane retardation value of ($Re=(n_x-n_y)d$) is 0 to 500 nm and thickness direction retardation value of ($Rth=(n_x-n_z)d$) is 0 to 500 nm and Re/Rth [sic] when the thickness of the film is d, primary in-plane refractive index is n_x and n_y, the primary refractive index in the thickness direction is n_z and $n_x>n_y$ [is being proposed].

[0004]

However, it is not possible to produce an optical compensation film that satisfies the above-mentioned characteristics by conventional uniaxial vertical drawing or uniaxial horizontal drawing. Furthermore, the above-mentioned characteristics can be partially achieved in sequential biaxial drawing used for production of standard packaging films but uniformity within the film is not sufficient.

[0005]

[Problems to be solved by the invention]

In order to eliminate the above-mentioned problems of the prior art, the purpose of the present invention is to provided an optical compensation film in which forming of biaxial characteristics is made easy and retardation characteristics required are uniformly included in the in-plane directions, and to provide a manufacturing method for it, and a polarizing film and liquid crystal display made of same.

[0006]

[Means to solve the problem]

In order to achieve the above-mentioned purpose, the present invention is a method of manufacturing an optical compensation film characterized by the fact that simultaneous drawing is done in the vertical direction and in the horizontal direction. In order to increase the film in-plane uniformity, it is desirable when a relaxation process for the horizontal drawing is provided after the simultaneous drawing process, and the relaxation ratio in said relaxation process is 20% or less.

[0007] Furthermore, the optical compensation film of the present invention produced by the above-mentioned method is [a film in which] in-plane retardation value of ($Re=(n_x-n_y)d$) is 0 to 500 nm and thickness direction retardation value of ($Rth=(n_x-n_z)d$) is 0 to 500 nm and Re/Rth [sic] when the thickness of the film is d, primary in-plane refractive indices are n_x and n_y, the primary refractive index in the thickness direction is n_z and $n_x>n_y$.

[0008] Furthermore, the optical compensation film of the present invention produced by the above-mentioned method is characterized by the fact that the in-plane retardation value ($Re=(n_x-n_y)d$) is 10 to 100 nm and thickness direction retardation value of ($Rth=(n_x-n_z)d$) is 100 to 300 nm and Re/Rth is 3 to 5 when the thickness of the film is d, the primary in-plane refractive indices are n_x and n_y, the primary refractive index in the thickness direction is n_z and $n_x>n_y$. Furthermore, the optical compensation film of the present invention is characterized by the fact that the Re distribution is within ±10% at 80% of the width of the sheet.

[0009]

Furthermore, it is desirable when the thermoplastic resin film is a norbornene type resin film.

[0010]

Furthermore, the polarizing sheet of the present invention is a polarizing sheet structured of a laminate of the aforementioned optical compensation film and polarizing sheet.

[0011]

Furthermore, the liquid crystal display device of the present invention is characterized by the fact that the aforementioned optical compensation film is provided on at least one side of the liquid crystal cell.

[0012]

And furthermore, the liquid crystal display device of the present invention is characterized by the fact that the aforementioned polarizing sheet is provided on at least one side of the liquid crystal cell.

[0013]

According to the manufacturing method of the present invention, reduction in the variation of the optical axis angle of the film is made possible and biaxial characteristics can be easily achieved; thus, viewing angle for observing the display as black and white can be increased when used as a polarizing sheet for a liquid crystal display device, and high contrast can be achieved and production of an optical compensation film having a wide viewing angle is made possible.

[0014]

[Embodiment of the invention]

For the thermoplastic resin films used in the present invention, polyester type resins such as polycarbonate resins, polyallylate and polyethylene terephthalate, polyolefin type resins such as polyimide resins, polystyrene resins, polyether sulfone resins, polystyrene resins, polyethylene, and polypropylene, polyvinyl alcohol type resins, cellulose acetate type resins, polyvinyl chloride type resins, polynorbornane type resins, polymethyl methacrylate resins, liquid crystal polymers, etc. can be mentioned. Production of the above-mentioned film may be carried out by the casting method, calendar method, or extrusion method. In particular, polycarbonate type resins, polystyrene type resins and polynorbornane type resins are desirable. In this case, polynorbornane type resins are especially desirable since the photoelastic coefficient is relatively low, and they are flexible, and furthermore, cracks and tears are less likely to form due to bending stress or shear stress. The weight average molecular weight of the thermoplastic resin is not especially limited, and suitable one can be selected.

[0015]

The thickness of the thermoplastic resin film subjected to drawing is not especially limited, and

the thickness can be determined according to the intended application, etc. of the drawn film. In general, a film with a thickness of 3 mm or below, for example, 1 μm to 1 mm, especially, 5 to 500 μm, is used from the standpoint of a uniform film based on stable drawing process.

[0016]

When simultaneous drawing in the vertical direction and horizontal direction in the present invention, pantagraph type (Hitachi Corp.), crescendo pitch screw type (KAMPH Co.), etc. can be used. A process is provided for relaxation of the horizontal drawing ratio after simultaneous biaxial drawing. A relaxation process is provided after the horizontal drawing process of simultaneous drawing and the number of times, etc. is not especially limited. When a relaxation process is provided, variations in the optical axis angle can be reduced. In the present invention, (1) a method where simultaneous biaxial drawing is carried out using the above-mentioned device, (2) a method where relaxation is provided after simultaneous biaxial drawing is carried out using the above-mentioned device, and (3) a method where relaxation is provided after simultaneous biaxial drawing is carried out using the above-mentioned device, and vertical and/or horizontal drawing is further performed, etc. can be mentioned.

[0017]

The drawing temperature used for the thermoplastic resin film varies depending on the type of resin used, and in general, a temperature in the range of 80 to 250 deg C, preferably, 120 to 200 deg C, and especially, 140 to 180 deg C can be used.

[0018]

The drawing ratio is 1 to 5 times in vertical direction and horizontal direction, and 1 to 2 times is further desirable and 1.1 to 1.5 times is especially desirable. The drawing ratio in the vertical direction and horizontal direction is vertical drawing ratio/horizontal drawing ratio=0.2 to 5.0, and 0.3 to 3.0 is further desirable and 0.5 to 1.0 is especially desirable. When the aforementioned drawing ratio is less than 0.2 or greater than 5.0, production of an optical compensation film having the target retardation value of the present invention cannot be

produced.

[0019]

In the relaxation process, the horizontally drawn thermoplastic resin film is retained at a specific temperature for a specific time and shrinkage of the film is allowed. It is desirable when the relaxation ratio is 20% or below, and 15% or below is further desirable. When the relaxation ratio is too high, the film becomes slack and runnability becomes inadequate, and in particular, variations increase. It is desirable when the retention temperature used is within the range of 30 deg C minus the glass transition point to 30 deg C plus the glass transition point of the above-mentioned thermoplastic resin. When the retention temperature is too high, the target characteristics (phase shift) cannot be achieved; on the other hand, when it is too low, molecular orientation is frozen during the course of drawing process and uniformalization of the retardation value is impossible. The retention time used in this case is in the range of 10 to 300 seconds, and 30 seconds to 180 seconds is further desirable. When the retention time is insufficient, stress relaxation effect achieved is inadequate and uniformalization of the retardation value is not possible; on the other hand, when it is too long, an increase in variation in the retardation value in the thickness direction occurs.

[0020]

According to the method of manufacturing of the present invention, [it is possible to produce a film] having an in-plane retardation value (Re) of 0 to 500 nm, thickness direction retardation value (Rth) of 0 to 500 nm and Re/Rth [of 3 to 5] when the thickness of the film is d, primary in-plane refractive index is n_x and n_y, the primary refractive index in the thickness direction is n_z and $n_x > n_y$.

[0021]

Furthermore, the optical compensation film produced by the manufacturing method of the present invention has the aforementioned in-plane retardation value (Re) of 10 to 100 nm and thickness direction retardation value of (Rth) of 100 to 300 nm and Re/Rth of 3 to 5.

[0022]

Furthermore, the optical compensation film produced by the manufacturing method of the present invention has an Re distribution within ±10% in the width direction of the sheet over 80% of the width of the sheet, and the variation in Re is insignificant and in-plane uniformity is high. In other words, the difference of Re in the film center area and the Re in the width direction is within ±10% of the Re in the center area when measurements of Re in the width direction of the film produced by the drawing method are made. The thickness of the film is appropriately determined according to the application purpose, etc., and in general, the thickness is 1 mm or below, preferably, in the range of 1 to 500 μm, and especially, in the range of 5 to 300 μm.

[0023]

The optical compensation film of the present invention may be used as a single sheet or as a laminate. The number of laminations is not limited, and from the standpoint of light transmittance, etc., lamination of 2 to 5 sheets is commonly done. The combination used for the drawn film laminate is not especially limited, and those having the same orientation angle or different orientation angles, those made of the same materials or different materials, those having the same phase shift or different phase shifts may be used in combination.

[0024]

In the following, the polarizing sheet used in the present invention is explained. The basic structure of the polarizing sheet used in the present invention consists of a protective layer of a transparent protective film applied to one or both surfaces of a polarizer made of a polyvinyl alcohol type polarizing film containing a dichroism material with an appropriate adhesive layer, for example, an adhesive layer made of a vinyl alcohol type polymer.

[0025]

For the polarizer (polarizing film), a suitable material produced by appropriate treatment of a film made of an appropriate vinyl alcohol type polymer such as polyvinyl alcohol and a partially

formulated polyvinyl alcohol treatment such as dyeing with a dichromic material made of iodine or dichromic dye, drawing treatment, and crosslinking treatment, and which is capable of transmitting linear polarized light can be used. Especially, those with superior light transmittance and polarization degree are desirable. In general, the thickness of the polarizing film is in the range of 5 to 80 μm, but it is not especially limited. [0026]

For the protective film material that forms the transparent protective layer provided for one or both surfaces of the polarizer (polarizing film), an appropriate transparent film may be used. In particular, a film made of a polymer having high transparency, mechanical strength, thermal stability and water blocking property, etc. can be used effectively. For examples of the above-mentioned polymer, acetate type resins such as triacetyl cellulose, polyester type resins, polyether sulfone type resins, polycarbonate type resins, polyamide type resins, polyimide type resins, polyolefin type resins, acrylic type resins, etc. can be mentioned, but the polymer is not limited to those listed above.

[0027]

From the standpoint of polarizing characteristics and durability, etc., a desirable transparent protective film is a triacetyl cellulose film the surface of which is treated by saponification with an alkali etc. The thickness of the transparent protective film is not especially limited, and in general, a thickness of 500 μm or less, preferably in the range of 5 to 300 μm, and especially in the range of 5 to 150 μm, is desirable from the standpoint of reduced thickness of the polarizing sheet. Furthermore, when a transparent protective film is provided for both surfaces of the polarizing film, transparent protective films made of different polymers may be used for each surface. As long as the purpose of the present invention is not lost, treatments such as hardcoat treatment, antireflective treatment, anti-stick treatment, diffusion resistance treatment, and anti-glare treatment, etc. may be provided for the transparent protective film used as the protective layer. A Hardcoat treatment is provided for the purpose of prevention of scratches on the surface of the polarizing film, and for example, a hardened film with high hardness and lubricity made of

appropriate ultraviolet curable resins such as silicone resins, urethane resins, acrylic resins, and epoxy resins, is applied to the surface of the transparent protective film.

[0028]

On the other hand, antireflective treatment is performed to prevent reflection of external light at the surface of the polarizing sheet, and formation of the antireflective film can be done in the usual manner. Furthermore, an anti-stick treatment is provided to prevent adhesion of adjacent layers and anti-glare treatment is provided to prevent blocking of visibility due to reflection of external light at the surface of the polarizing sheet, and for example, formation of a fine rough surface can be performed on the surface of the transparent protective film using a rough surface formation method such as sand blasting and embossing, or mixing of transparent fine particles.

[0029]

For the above-mentioned transparent fine particles, silica, alumina, titania, zirconium, tin oxide, indium oxide, cadmium oxide, antimony oxide, etc. having a mean particle diameter of 0.5 to 20 μm can be mentioned, and electrically conductive inorganic fine particles may be used, and furthermore, organic fine particles made of crosslinked or non-crosslinked polymer particles may be used as well. The amount of transparent fine particles used is in the range of 2 to 70 mass parts, in general, 5 to 50 mass parts, for 100 mass parts of the transparent resin.

[0030]

The anti-glare layer with transparent fine particles may be used as a transparent protective film itself or as a layer coated on the surface of the transparent protective film. Furthermore, the anti-glare layer may double as a diffusion layer (viewing angle compensation function, etc.) for increased viewing angle. Furthermore, the above-mentioned antireflective layer, anti-sticking layer, diffusion layer, anti-glare layer, etc. may be optical layers independent from the transparent protective film.

[0031]

Adhesion of the aforementioned polarizer (polarizing film) and transparent protective film used

as protective layer is not especially limited, and for example, an adhesive made of a vinyl alcohol polymer or a vinyl alcohol polymer containing at least a water-soluble crosslinking agent such as boric acid, borax, glutaraldehyde, melamine, or oxalic acid may be used. In this case, peeling is less likely to occur due to heat and humidity, and superior light transmittance and degree of polarization can be achieved. The above-mentioned adhesive layer is formed as a dried, coated layer of an aqueous solution, and in production of said solution, other additives and catalysts such as acids may be included as needed.

[0032]

In application, the polarizer may be used as an optical component laminated with other optical layers. The optical layers used are not especially limited, and for example, one or more layers of appropriate optical components used for formation of liquid crystal display devices such as reflective sheet, semi-transparent reflective sheet, phase shift sheet (includes lambda sheet such as half-wavelength sheet and quarter-wavelength sheet), the optical compensation film of the present invention and brightness enhancing film, and in particular, a reflective type polarizing sheet or semi-transparent reflective type polarizing sheet in which a reflective sheet or semi-transparent reflective sheet is further laminated onto a polarizing sheet consisting of a polarizer and protective layer, an elliptically polarized sheet or a linearly polarizing sheet in which a phase shift sheet is further laminated onto the aforementioned polarizing sheet consisting of a polarizer and protective layer, a polarizing sheet in which the optical compensation film of the present invention is further laminated onto the aforementioned polarizing sheet consisting of a polarizer and protective layer, and a polarizing sheet in which a brightness enhancing film is further laminated onto the aforementioned polarizing sheet consisting of a polarizer and protective layer are further desirable.

[0033]

The aforementioned reflective sheet is used for formation of reflective type polarizing sheet using a polarizing sheet, and in general, the reflective type polarizing sheet is provided on the

back side of the liquid crystal cell to form a liquid crystal display device where the incident light from the viewing side (display side) is reflected and display is achieved, and a built-in light source such as a backlight can be omitted and reduction in the thickness of the liquid crystal display device is likely to be achieved.

[0034]

Formation of the reflective type polarizing sheet is achieved using a method consisting of depositing a reflective layer made of a metal, etc. onto one surface of the polarizing sheet with the above-mentioned optional transparent protective film, etc. As a specific example, a reflective layer produced by depositing a foil or film made of a reflective metal such as aluminum on one surface of a matted transparent protective film can be mentioned. [0035]

Furthermore, a reflective type polarizing sheet having a reflective layer enhanced with the fine uneven structure on the above-mentioned transparent protective film containing fine particles to provide a fine uneven structure can be mentioned as well. A reflective layer having a fine, textured structure on the surface is used for diffusion of incident light to prevent directivity and glare and to control non-uniform brightness. Formation of the reflective layer enhanced with a fine, textured structure based on a surface with fine, textured structure of the transparent protective film can be achieved by depositing a metal directly onto the surface of the protective film using a deposition method such as vacuum deposition, ion plating, or sputtering or plating method.

[0036]

Furthermore, instead of the above-mentioned method where the reflective sheet is deposited directly onto the transparent protective film of the polarizing sheet, a reflective layer may be formed on an appropriate film corresponding to the transparent protective film and used as a reflective sheet as well. In general, the reflective layer of the polarizing sheet is made of a metal; thus, from the standpoint of reduction in reflectivity due to oxidation and maintaining long-lasting initial reflectivity and elimination of the protective layer formed separately, it is desirable

when the reflective surface is covered with a film or polarizing sheet when in use.

[0037]

Furthermore, formation of the semi-transparent polarizing sheet is achieved when a semi-transparent type reflective layer such as a half-mirror where light is both reflected and transmitted at the reflective layer is used. In general, the semi-transparent polarizing sheet is provided on the back side of the liquid crystal cell and used for a liquid crystal display device in which the incident light from the viewing side (display side) is reflected and image is displayed when the liquid crystal display device is used in a relatively bright area, and image display is achieved with a built-in light source such as backlight provided on the back side of the semi-transparent polarizing sheet when used in a relatively dark area. In other words, the semi-transparent polarizing sheet can be used effectively for production of a liquid crystal display device where energy-savings for a light source such as backlight is possible

when the semi-transparent polarizing sheet is used in a bright area, and display is made possible in a relatively dark area with the built-in light source.

[0038]

When natural light enters the brightness enhancing film, the linearly polarized light of a specific polarization axis or circularly polarized light of a specific direction is reflected, and other light is transmitted, and a polarizing sheet of the brightness enhancing film and a polarizing sheet consisting of the above-mentioned polarizer and protective layer let the light from a light source such as backlight in to form transmitted light with a specific polarization state and light other than the aforementioned specific polarization state is not transmitted but is reflected. The light reflected by the above-mentioned brightness enhancing film is reversed through the reflective layer, etc. provided on the backside and re-enters the brightness enhancing sheet and a part or all of the light is transmitted as a light of specific polarization state to increase the light transmitted through the brightness enhancing film, and at the same time, the polarized light less likely to be absorbed by the polarizer is supplied and the quantity of light that can be used for the liquid

crystal image display, etc. is increased to enhance the brightness.

[0039]

For the aforementioned brightness enhancing film, those that transmit linearly polarized light of a specific polarization axis and reflect the remaining light as in a multilayer thin-film dielectric or multilayer laminate of thin films having different refractive index anisotropies, those that reflect one form of circularly polarized light, that is of left rotation or right rotation, and transmit the remaining light, as in the case of a cholesteric liquid crystal layer, in particular, the oriented film of cholesteric liquid crystal film or oriented liquid crystal layer on a film base, etc., can be used.

[0040]

Therefore, in a brightness-enhancing film that transmits the above-mentioned linearly polarized light of a specific polarization axis, absorption loss based on a polarizing sheet can be controlled and efficient transmission can be achieved when the transmitted light is injected to the polarizing sheet at a specific polarization axis. On the other hand, in the brightness-enhancing film where the linearly polarized light is transmitted as in the case of cholesteric liquid crystal layer, [the light] may be directly injected to the polarizer, but from the standpoint of controlling the absorption loss, it is desirable when the transmitted circularly polarized light is converted to linearly polarized light through a phase shift sheet and injected to the polarizing sheet. Furthermore, when a quarter-wavelength board is used as a phase shift sheet, it is possible to convert the circularly polarized light into linearly polarized light.

[0041]

Production of a phase shift sheet that functions as a quarter-wavelength board over a wide wavelength range such as the visible light region is possible when a phase shift layer that functions as a quarter-wavelength board for monochromatic light such as light with a wavelength of 550 nm and other phase shift layer having different phase shift characteristics, for example, a phase shift layer that functions as a half-wavelength board, are superposed. Thus, the phase shift sheet arranged between the polarizing sheet and brightness-enhancing film may comprise a single

layer or two or more layers of phase shift sheets.

[0042]

Furthermore, when two or more cholesteric liquid crystal layers with different reflective wavelengths are superposed, reflection of circularly polarized light over a wide wavelength region such as the visible light region, and thus, production of transmitted circularly polarized light with a wide wavelength range is made possible.

[0043]

In the following, a polarizing sheet in which an optical compensation film is further laminated onto the aforementioned polarizing sheet is explained.

[0044]

In the above-mentioned polarizing sheet, at least one layer of optical compensation film of the present invention is laminated onto the above-mentioned polarizing sheet and the polarizing sheet may comprise two or more laminate layers. Therefore, a combination of the above-mentioned reflective type polarizing sheet or semi-transparent polarizing sheet and the optical compensation film of the present invention may be used to form a reflective type elliptically polarized sheet or semi-transparent type elliptically polarized sheet. The lamination method is not especially limited, and an adhesive means such as pressure-sensitive adhesive layer may be used. Production of a polarizing sheet in which two or more optical layers are laminated may be carried out during the course of production of a liquid crystal display device, etc., but superior and stable quality and ease of assembly can be achieved when lamination is performed ahead of time to form an optical component and used as an integral polarizing sheet with optical compensation sheet.

[0045]

Furthermore, a liquid crystal display device having the optical compensation film of the present invention or the polarizing sheet of the above-mentioned polarizing sheet further laminated with the optical compensation film of the present invention on at least one side of a liquid crystal cell

is explained below.

[0046]

The liquid crystal display device of the present invention may be a transmission type, or reflection type, or transmission-reflection type having a polarizing sheet on one or both sides of the liquid crystal cell. Therefore, the liquid crystal cell that structures the liquid crystal display device is not limited, and an appropriate liquid crystal cell such as active matrix driven type represented by thin film transistor and simple matrix driven type represented by twist nemaic type or super twist nemaic type may be used.

[0047]

Furthermore, when a polarizing sheet or optical component are provided for both sides of the liquid crystal cell, they may be the same or different. And furthermore, in production of the liquid crystal display device, one or more layers of components such as prism array sheet, lens array sheet, light-diffusing sheet and backlight may be arranged at appropriate positions.

[0048]

In order to apply the optical compensation film or polarizing sheet of the present invention with liquid crystal cell, an adhesive layer may be provided. Formation of the adhesive layer may be done with a conventional adhesive such as acrylic adhesive. In particular, in order to prevent foaming or peeling due to moisture absorption, reduction of optical characteristics or prevention of warping of the liquid crystal cell due to difference in coefficient of thermal expansion, and for production of a liquid crystal display device with high quality and high durability, it is desirable when an adhesive layer with low moisture absorption and high heat-resistance is used. Furthermore, fine particles may be included to form an adhesive layer with light diffusion characteristics.

[0049]

When the adhesive layer provided for the polarizing sheet or optical component is exposed on the surface, a temporary cover with a separator is desirable to prevent soiling before use. Production

of a separator can be done in the form of a release coat with an appropriate release agent such as a silicone type, long-chain alkyl type, fluorine type, or molybdenum sulfide type release agent applied to an appropriate thin film such as the above-mentioned transparent protective film.

[0050]

Furthermore, the above-mentioned polarizing film or transparent protective film that structures the polarizing sheet or optical component, and each optical layer, adhesive layer, etc. may be treated with an ultraviolet absorber such as a salicylate compound, benzophenone compound, benzotriazole compound, cyanoacrylate compound, nickel complex salt compound, etc. by an appropriate means. The present invention is further explained in specific terms below.

[0051]

[Working Examples]

(Working Example 1)

Simultaneous biaxial drawing was carried out for a polynorbornene type resin film with a thickness of 100 μm (product of JSR, trade name "Arton film") by a simultaneous biaxial stretcher at a drawing temperature of 180 deg C to 1.10 times in the vertical direction and to 1.15 times in the horizontal direction and production of an optical compensation film having a film center thickness of 81 μm and width of 345 mm was achieved.

[0052]

(Working Example 2)

Simultaneous biaxial drawing was performed for a polynorbornene type resin film with a thickness of 100 μm (product of JSR, trade name "Arton film") by a simultaneous biaxial stretcher at a drawing temperature of 180 deg C to 1.10 times in the vertical direction and to 1.15 times in the horizontal direction. Furthermore, relaxation was performed for the above-mentioned drawn film at a temperature of 180 deg C for 60 seconds until a film width of 98% was achieved and production of an optical compensation film having a film center thickness of 81 μm and width of 345 mm was achieved.

[0053]

(Comparative Example 1)

Drawing was carried out for a polynorbornene type resin film with a thickness of 100 μm (product of JSR, trade name "Arton film") between two pairs of pinch rolls utilizing perimeter speed difference at a drawing temperature of 180 deg C to 1.10 times in the vertical direction; then, drawing was performed to 1.50 times in the horizontal direction at a drawing temperature of 180 deg C by a tenter and production of an optical compensation film having a film center thickness of 66 μm and width of 360 mm was achieved.

[0054]

(Comparative Example 2)

Drawing was carried out for a polynorbornene type resin film with a thickness of 100 μm (product of JSR, trade name "Arton film") between two pairs of pinch rolls utilizing perimeter speed difference at a drawing temperature of 180 deg C to 1.10 times in the vertical direction, then, drawing was performed to 1.15 times in the horizontal direction at a drawing temperature of 180 deg C by a tenter and production of an optical compensation film having the film center thickness of 80 μm and width of 320 mm was achieved.

[0055]

(Evaluation of properties of optical compensation film)

Measurements were made of $Re=(n_x-n_y)d$, $Rth=(n_x-n_z)d$, and Re/Rth of the film center by an automatic birefringence ratio meter (KOBRA21ADH) of Oji Instrument Co. as d for the thickness of the optical compensation film of Working Examples and comparative examples, n_x and n_y for the film in-plane refractive index and n_z for the primary refractive index in the thickness direction. And the results obtained are shown in Table I below. Furthermore, in order to measure variation in Re in the horizontal direction of the optical compensation film, measurement of Re in the horizontal direction was performed, and a calculation was made of the ratio of the film horizontal width for the total horizontal width in which difference between the

film center Re and horizontal direction Re is within ±10%. And the results obtained are shown in Table I.

[0056]

Table I

	Re	Rth	Axis angle of Re/Rth transverse direction		Characteristic variation of transverse direction
	(nm)	(nm)	[blank]	variation (deg)	Ratio within 10% (%)
Working Example 1	10.5	43.7	0.24	12	33
Working Example 2	7.9	35.9	0.22	5	39
Comparative Example 1	58.7	157.8	0.37	9	43
Comparative Example 2	43.2	70.8	0.61	10	35

[Translator's note: The table is based on the table provided in the Paterra machine translation. The original Japanese table was not available for translation.]

[0057]

As shown in the results above, in comparison to optical compensation films of comparative examples, the retardation value (Re/Rth) of the optical compensation films of the present invention is low and when the relaxation process is provided, variation in the axis angle in the horizontal direction is insignificant and uniform in-plane characteristics are achieved.

[0058]

(Working Example 3)

An elliptically polarized sheet comprising a laminate of the optical compensation film produced in Working Example 2 above and a polyvinyl alcohol type polarizing sheet was applied to both

sides of an STN type liquid crystal cell to produce a display device. As a result, coloring was not observed over a wide range and good contrast was achieved.

[0059]

[Effect of the invention]

As explained in detail above, simultaneous drawing is carried out for the thermoplastic resin film in the vertical direction and horizontal direction; thus, two separate drawing processes of sequential biaxial drawing are not required and the number of production steps can be reduced. And furthermore, according to the manufacturing method of the present invention, a reduction in the variation in the optical axis angle of the film is made possible and biaxial characteristics can be easily achieved, and production of an optical compensation film having uniform in-plane characteristics is made possible.